

## Melvin Leok: Curriculum Vitae

Department of Mathematics  
University of California, San Diego  
9500 Gilman Drive, Dept. 0112,  
La Jolla, CA 92093-0112, USA.

*phone:* +1(858)534-2126  
*fax:* +1(858)534-5273  
*e-mail:* mleok@math.ucsd.edu  
*homepage:* <http://www.math.ucsd.edu/~mleok/>

### Education

#### CALIFORNIA INSTITUTE OF TECHNOLOGY

- Ph.D. Control & Dynamical Systems, Applied & Computational Mathematics (minor) Oct 2000–Jun 2004  
*Thesis:* *Foundations of Computational Geometric Mechanics*  
*Committee:* *Jerrold E. Marsden (advisor, deceased), Thomas Y. Hou, Richard M. Murray, Michael Ortiz, and Alan D. Weinstein (Mathematics, UC Berkeley).*
- M.S. Mathematics Oct 1999–Jun 2000  
B.S. Mathematics (*with honor*) Oct 1996–Jun 2000

### Professional Experience

- Associate Professor (Tenured), Mathematics, University of California, San Diego. Jul 2009–present  
Visiting Assistant Professor, Control & Dynamical Systems, California Institute of Technology. Apr–Jun 2009  
Assistant Professor (Tenure-Track), Mathematics, Purdue University. Aug 2006–May 2009  
T.H. Hildebrandt Research Assistant Professor, Mathematics, University of Michigan. Sep 2004–Aug 2006  
Postdoctoral Scholar, Control & Dynamical Systems, California Institute of Technology. Jul–Aug 2004

### Research Interests

- Computational Geometric Mechanics:** Applying discrete differential geometry and discrete Lagrangian and Hamiltonian mechanics to the construction of geometric structure-preserving numerical algorithms.
- Computational Geometric Control Theory:** Construction of real-time digital feedback control of mechanical systems using techniques from geometric control theory and computational geometric mechanics.
- Numerical Analysis:** Derivation of accurate and efficient numerical schemes with good long-time geometric stability properties by combining geometric integration with adaptive, spectral, and multiscale techniques.

### Research Prizes and Honors

- Kavli Fellow* (German-American Kavli Frontiers of Science Symposium), National Academy of Sciences. 2012  
*Purdue University Nominee* for Packard Fellowship for Science and Engineering. 2009  
*SciCADE New Talent Prize*, International Conference on Scientific Computation and Differential Equations. 2007  
*SIAM Student Paper Prize*, Society for Industrial and Applied Mathematics. 2003  
*Leslie Fox Prize in Numerical Analysis* (second prize), Institute of Mathematics and its Applications, UK. 2003

### Research Grants

(Total of \$857,432 in single PI awards, \$454,905 in joint awards)

- NSF Focused Research Group Grant*, DMS-1065972. \$454,905, co-PI (PI: Michael Holst). 2011–2014  
*NSF Dynamical Systems Grant*, CMMI-1029445. \$111,134, single PI. 2010–2013  
*NSF CAREER Award*, DMS-1010687 (formerly DMS-0747659). \$455,188, single PI. 2008–2013  
*NSF Computational Mathematics Grant*, DMS-1001521 (formerly DMS-0714223). \$163,743, single PI. 2007–2011  
*NSF Applied Mathematics Grant*, DMS-0726263 (formerly DMS-0504747). \$108,067, single PI. 2005–2009  
*Margaret and Herman Sokol Spring/Summer Research Grant*, University of Michigan. \$4,000, single PI. 2006  
*Horace H. Rackham Faculty Fellowship*, University of Michigan. \$7,000, single PI. 2005  
*Horace H. Rackham Faculty Grant*, University of Michigan. \$7,300, single PI. 2004–2005  
*Grant-in-Aid of Research*, Sigma Xi, The Scientific Research Society. \$1,000, single PI. 2001

### Travel Awards

- USACM Young Investigator Fellowship*, World Congress on Computational Mechanics. 2008  
*ICM Travel Grant*, NSF DMS-0514413, American Mathematical Society. 2006  
*ICIAM Travel Grant*, NSF DMS-0218051, Society for Industrial and Applied Mathematics. 2003  
*London Mathematical Society Bursary*, Short Course on Computational Differential Equations. 2002  
*SIAM Student Travel Award*, SIAM Conference on Applications of Dynamical Systems. 2001

### Graduate Fellowships

- Josephine de Kármán Fellowship* (established by Theodore von Kármán). 2003–2004  
*International Fellowship*, Agency for Science, Technology and Research, Singapore. 2002–2004  
*Poincaré Fellowship* (Betty and Gordon Moore Fellowship), Caltech. 2000–2004  
*Tau Beta Pi Fellowship*, Tau Beta Pi, National Engineering Honor Society. 2000–2001  
*Tan Kah Kee Foundation Postgraduate Scholarship*, Singapore. 2000

## Melvin Leok: Curriculum Vitae

### Selected Honors and Awards

<i>Herbert J. Ryser Scholarship</i> , Caltech Mathematics Department.	1999
<i>E. T. Bell Undergraduate Mathematics Research Prize</i> , Caltech Mathematics Department.	1999
<i>Jack E. Froehlich Memorial Award</i> , Caltech.	1999
<i>Sigma Xi</i> , The Scientific Research Society (Associate Member / Full Member).	1999, 2005
<i>Tau Beta Pi</i> , National Engineering Honor Society.	1999
<i>Upperclass Merit Award (Carnation Scholarship)</i> , Caltech.	1998, 1999
<i>Loke Cheng-Kim Foundation Scholarship</i> , Singapore.	1996–2000
<i>Lee Kuan Yew Award for Mathematics and Science</i> , Ministry of Education, Singapore.	1994
<i>Top Prize, First Step to Nobel Prize in Physics</i> , Polish Academy of Sciences.	1993
<i>Student of the Year</i> , Computer Science Faculty, Raffles Junior College, Singapore.	1993
<i>Bronze medal, 4th International Olympiad in Informatics</i> , Bonn, Germany.	1992

### Invited Colloquia

Center for Applied Mathematics Colloquium, Cornell University, Ithaca, NY.	Feb 2012
Mathematics Colloquium (Oliver Club), Cornell University, Ithaca, NY.	Feb 2012
Mathematics Colloquium, Penn State University, State College, PA.	Nov 2011
Colloquium, Engineering Science and Applied Mathematics, Northwestern University, Evanston, IL.	Oct 2011
Colloquium, Mathematics, Statistics, and Computer Science, University of Illinois, Chicago, IL.	Apr 2011
Colloquium, School of Mathematical and Statistical Sciences, Arizona State University, Tempe, AZ.	Oct 2009
Computational and Applied Mathematics Colloquium, Penn State University, State College, PA.	Oct 2009
Mathematics Special Colloquium, University of Minnesota, MN.	Dec 2008
Mathematics Special Colloquium, University of California, San Diego, CA.	Nov 2008
Center for Applied Mathematics Colloquium, University of Notre Dame, Notre Dame, IN.	Nov 2008
Center for Applied Mathematics Colloquium, University of Notre Dame, Notre Dame, IN.	Apr 2007
Mathematics Colloquium, University of Iowa, Iowa City, IA.	Mar 2007
Applied Mathematics Colloquium, University of Maryland, Baltimore County, MD.	Nov 2006
Mathematical Sciences Colloquium, Rensselaer Polytechnic Institute, Troy, NY.	Oct 2006
Mathematics Colloquium, Colorado School of Mines, CO.	Feb 2006
Mathematics Colloquium, University of South Carolina, SC.	Feb 2006
Mathematics Colloquium, Texas A&M University, College Station, TX.	Feb 2006
Mathematics Colloquium, Colorado State University, Fort Collins, CO.	Feb 2006
Mathematics Special Colloquium, Purdue University, West Lafayette, IN.	Feb 2006
Mathematics Colloquium, University of California, San Diego, CA.	Dec 2004

### Invited Seminar Talks

PIMS Seminar, University of British Columbia, Vancouver, Canada.	Aug 2010
Informal Numerical Analysis Seminar, Rutgers University, Piscataway, NJ.	May 2010
Applied Mathematics Seminar, California State University, Northridge, CA.	Apr 2010
Center for Computational Mathematics Seminar, University of California, San Diego, CA.	Apr 2010
Cymer Center for Control Systems and Dynamics Seminar, University of California, San Diego, CA.	Apr 2010
Mechanics and Control Seminar, Beijing Institute of Technology, Beijing, China.	May 2009
Applied Mathematics Seminar, Stanford University, Palo Alto, CA.	May 2009
Applied Mathematics and Statistics Seminar, Johns Hopkins University, Baltimore, MD.	Feb 2009
Physical Mathematics Seminar, Massachusetts Institute of Technology, Cambridge, MA.	Feb 2009
Applied Mathematics Seminar, Texas A&M University, College Station, TX.	Dec 2008
CDS Seminar, Caltech, Pasadena, CA.	Nov 2008
Applied and Interdisciplinary Mathematics Seminar, University of Michigan, Ann Arbor, MI.	Nov 2008
Dynamics Seminar, Department of Mathematics, Cornell University, NY.	Oct 2008
Scientific Computing Seminar, Department of Mathematics, Tsinghua University, Beijing, China.	Jun 2008
Institute of Computational Mathematics Seminar, Chinese Academy of Sciences, Beijing, China.	Jun 2008
Applied and Computational Mathematics Seminar, University of Auckland, New Zealand.	Dec 2007
Applied Mathematics and PDE Seminar, University of Wisconsin, Madison, WI.	Oct 2007
Applied Mathematics Seminar, Imperial College, London, UK.	May 2007
Highly Oscillatory Problems Seminar, Newton Institute, University of Cambridge, UK.	May 2007
CDS/CIMMS Lunchtime Seminar, Caltech, Pasadena, CA.	Dec 2006
Geometry and Dynamical Systems with Applications Seminar, Arizona State University, Tempe, AZ.	Apr 2006
Dynamics Seminar, University of Colorado, Boulder, CO.	Feb 2006

## Melvin Leok: Curriculum Vitae

### Invited Seminar Talks (Continued)

Applied and Interdisciplinary Mathematics Seminar, University of Michigan, Ann Arbor, MI.	Feb 2006
Numerical Analysis and Differential Equations Seminar, North Carolina State University, Raleigh, NC.	Jan 2006
Applied Mathematics Seminar, Mathematics, University of Waterloo, Canada.	Dec 2005
Control Seminar, College of Engineering, University of Michigan, Ann Arbor, MI.	Oct 2005
Differential Geometry and Analysis Seminar, University of Toledo, Toledo, OH.	Sep 2005
Computer and Computational Sciences, CCS-2, LANL, Los Alamos, NM.	Aug 2005
Special Seminar, Mathematics, University of California, Berkeley, CA.	Apr 2005
Mathematical Physics Seminar, University of Minnesota, Twin Cities, MN.	Mar 2005
Numerical Analysis and Differential Equations Seminar, North Carolina State University, Raleigh, NC.	Jan 2005
Flight Dynamics and Control Seminar, Aeronautics, University of Michigan, Ann Arbor, MI.	Oct 2004
Geometry Seminar, University of Michigan, Ann Arbor, MI. (2 talks)	Oct 2004
Applied Mathematics Seminar, University of California, San Diego, CA.	Aug 2004
Temasek Laboratories, National University of Singapore.	Jul 2004
Mathematics Department, National University of Singapore. (4 talks)	Jul 2004
Institute for High Performance Computing, National University of Singapore.	Jul 2004
SIAM Student Chapter, Caltech, Pasadena, CA.	Jan 2004
Applied Math and Numerical Analysis Seminar, University of Minnesota, Twin Cities, MN.	Jan 2004
School of Engineering and Science, International University of Bremen, Germany.	Sep 2003
Paderborn Institute for Scientific Computation, University of Paderborn, Germany.	Sep 2003
Caltech/JPL Nonlinear Astrodynamics Group, Pasadena, CA.	Aug 2003
Institute for High Performance Computing, National University of Singapore.	Feb 2003
Center for Integrative Multiscale Modeling and Simulation, Caltech, Pasadena, CA.	May 2002
Culham Electromagnetics and Lightning Ltd, Abingdon, Oxfordshire, UK.	Apr 2002
Department of Informatics, University of Bergen, Bergen, Norway.	Oct 2001
Department of Mathematical Sciences, NTNU, Trondheim, Norway.	Oct 2001
Mathematics Department, National University of Singapore.	Aug 2000
Center for Remote Imaging, Sensing and Processing, National University of Singapore.	Sep 1999

### Invited Conference Talks

Geometric Mechanics and Control Theory, Indian Institute of Science, Bangalore, India.	Aug 2013
Applied Dynamics and Geometric Mechanics Workshop, Oberwolfach, Germany.	Aug 2011
Rough Paths and Combinatorics in Control Theory, UCSD, La Jolla, CA.	Jul 2011
Computational Methods in Dynamics, ICTP, Trieste, Italy.	Jul 2011
KAM Theory and Geometric Integration Workshop, BIRS, Canada.	Jun 2011
Seventh Annual Structured Integrators Workshop, Caltech, Pasadena, CA.	May 2011
Geometric Numerical Integration Workshop, Oberwolfach, Germany.	Mar 2011
New Geometric and Numeric Tools for the Analysis of Differential Equations, BIRS, Canada.	Aug 2010
Sixth Annual Structured Integrators Workshop, University of California, San Diego, CA.	Apr 2010
XVIII International Fall Workshop on Geometry and Physics, Benasque, Spain.	Sep 2009
Fifth Annual Structured Integrators Workshop, Caltech, Pasadena, CA.	May 2009
Fourth Annual Structured Integrators Workshop, Stanford, CA.	Apr 2008
Geometric Mechanics Workshop, Banff International Research Station, Banff, Canada.	Aug 2007
Discrete Differential Geometry, Berlin, Germany.	Jul 2007
New Talent Plenary Lecture, SciCADE 2007, Saint Malo, France.	Jul 2007
Effective Computational Methods for Highly Oscillatory Problems, Newton Institute, Cambridge, UK.	Jul 2007
International Summer School on Geometry, Mechanics, and Control, Castro Urdiales, Spain.	
(One of three principal lecturers, 7 hours)	Jun 2007
Turbulence Working Group Workshop, T-7, LANL, Santa Fe, NM.	Dec 2003
Full Body Problem Workshop, Caltech, Pasadena, CA.	Nov 2003
Leslie Fox Prize Meeting, University of Cambridge, UK.	Jun 2003
Student Paper Prize Presentation, SIAM Annual Meeting, Montréal, Canada.	Jun 2003
Geometrical Mechanics and Turbulence Modeling, CNLS, LANL, Santa Fe, NM.	Nov 2002
Geometry, Symmetry and Mechanics II, University of Warwick, UK.	Jul 2002
Invariant and Symmetry-Preserving Integrators for $N$ -Body Simulation, University of Leicester, UK.	Apr 2002
Reduced Dimensional Modeling Workshop, CNLS, LANL, Los Alamos, NM.	Nov 2001

## Melvin Leok: Curriculum Vitae

### Invited Minisymposium Talks

Exploiting Geometry in the Development of Numerical Methods of PDEs, SIAM PDEs, San Diego, CA.	Nov 2011
Marsden Memorial, ICIAM, Vancouver, Canada.	Jul 2011
Symmetry in Variational Problems, SIAM Dynamical Systems, Snowbird, UT.	May 2011
Geometric Control on Nonlinear Manifolds, IEEE CDC, Atlanta, GA.	Dec 2010
Nonlinear Dynamics and Control, CAIMS Annual Meeting, St. John's, Newfoundland, Canada.	Jul 2010
Computational Methods for Dynamical Systems Analysis, USNCTAM 2010, State College, PA.	Jun 2010
Applications to Computational Mechanics, SciCADE 2009, Beijing, China.	May 2009
Geometric Mechanics and its Applications, SIAM Dynamical Systems, Snowbird, UT.	May 2009
Geometric Mechanics, Control, and Integrability, AMS Southeastern Sectional Meeting, Huntsville, AL.	Oct 2008
Advances in Time-Integration, World Congress on Computational Mechanics, Venice, Italy.	Jul 2008
Geometric Integration and Computational Mechanics, Foundations of Computational Mathematics, City University of Hong Kong, Hong Kong, China.	Jun 2008
Geometric Numerical Integration, Joint Meeting of the AMS - NZMS, Wellington, New Zealand.	Dec 2007
Geometric and Symplectic Integration, SciCADE 2007, Saint-Malo, France.	Jul 2007
Geometric Methods in Dynamical Systems, SIAM Dynamical Systems, Snowbird, UT.	May 2007
Applications of the Geometric Phase in Classical Mechanics, SIAM Annual Meeting, Boston, MA.	Jul 2006
Contemporary Dynamical Systems, AMS Annual Meeting, San Antonio, TX.	Jan 2006
Geometric Dynamics and its Applications, SIAM Dynamical Systems, Snowbird, UT.	May 2005
Geometric Dynamics and Applications, AIMS Fifth International Conference on Dynamical Systems and Differential Equations, Pomona, CA.	Jun 2004
Geometric Methods for PDEs, NUMDIFF, University of Halle, Germany.	Sep 2003
Non-Grid based Methods for Geophysical and Astrophysical Flows, ICIAM, Sydney, Australia.	Jul 2003
Structure-Preserving Algorithms, SciCADE 2003, Trondheim, Norway.	Jul 2003
Discrete Geometry and Geometric Integration, SIAM Dynamical Systems, Snowbird, UT.	May 2003
Geometric Integration and Computational Dynamics, Foundations of Computational Mathematics, Minneapolis, MN.	Aug 2002
Geometric Integration, SIAM Dynamical Systems, Snowbird, UT. <i>SIAM Student Travel Award.</i>	May 2001

### Contributed Talks

Groupoidfest, University of California, Riverside, CA.	Nov 2008
MSRI Workshop on Application of Topology in Science and Engineering, Berkeley, CA.	Sep 2006
Geometric Numerical Integration Workshop, Oberwolfach, Germany.	Mar 2006
Frontiers of Applied Analysis, Pittsburgh, PA.	Sep 2005
IPAM Relativistic Astrophysics Workshop, Los Angeles, CA.	May 2005
Southern California Applied Mathematics Symposium, Claremont, CA.	Apr 2004
Auckland Numerical Ordinary Differential Equations, Auckland, New Zealand.	Jul 2003
International Congress on Industrial and Applied Mathematics, Sydney, Australia.	Jul 2003
Biennial Conference on Numerical Analysis, Dundee, Scotland.	Jun 2003
Mechanics and Symmetry European Summer School, Peyresq, France.	Sep 2001
Southwest Regional Workshop on New Directions in Dynamical Systems, USC, Los Angeles, CA.	Nov 2000
Caltech SURF Seminar Day, Pasadena, CA.	Oct 1999
Caltech SURF Seminar Day, Pasadena, CA. <i>Semi-finalist, Perpall Speaking Competition.</i>	Oct 1998

### Contributed Posters

Advanced Computational Electromagnetics Workshop, Boston, MA.	May 2006
New Paradigms in Computation, IMA Tutorial/Workshop, Minneapolis, MN.	Mar 2005
Compatible Spatial Discretizations for Partial Differential Equations, Institute for Mathematics and its Applications "Hot Topics" Workshop, Minneapolis, MN.	May 2004
ARO-Institute for Collaborative Biotechnologies Review, UCSB, Santa Barbara, CA.	Jul 2003, Feb 2004
International Congress on Industrial and Applied Mathematics, Sydney, Australia.	Jul 2003
CIMMS-IPAM Workshop on Molecular Modeling and Computation, Pasadena, CA.	Nov 2002
DARPA/NSF OPAAL Workshop, Seattle, WA.	May 2001
Southern California Applied Mathematics Symposium, Caltech, Pasadena, CA.	May 2001
Dynamics Days 2000, Santa Fe, NM.	Jan 2000
SIAM Conference on Applications of Dynamical Systems, Snowbird, UT.	May 1999, 2003
NSF-KDI/IGPP Workshop on accurate simulation and modeling of physical systems, San Diego, CA. <i>Student Poster Silver Medal Award in 1998.</i>	Nov 1998, 1999, 2000

## Melvin Leok: Curriculum Vitae

### Research Visits, Conferences and Summer Schools

Geometric and Topological Methods in Control and Robotics, Madrid, Spain. <sup>†,‡</sup>	Oct 2010
Geometry, Mechanics, and Dynamics, CIRM, France. <sup>‡</sup>	Jul 2010
HarrisFest, University of Michigan, Ann Arbor, MI. <sup>‡</sup>	May 2010
Groupoidfest, University of California, Riverside, CA. <sup>‡</sup>	Nov 2008
Laboratory of Scientific and Engineering Computing, Institute of Computational Mathematics, Chinese Academy of Sciences, Beijing, China. Host: Prof. Jialin Hong. <sup>‡,‡</sup>	Jun 2008
Visiting Fellow, Highly Oscillatory Problems: Computation, Theory and Application, Newton Institute, University of Cambridge. <sup>†,‡</sup>	May 2007
Geometry of Mechanism Science, Notre Dame, IN. <sup>†</sup>	Mar 2007
IMA Tutorial: Algebraic Geometric Methods in Engineering, Minneapolis, MN. <sup>†</sup>	Sep 2006
International Congress of Mathematicians, Madrid, Spain. <sup>‡</sup>	Aug 2006
Multiscale Modeling and Computation - Basic Theory and the Geosciences, Caltech, Pasadena, CA. <sup>†</sup>	Nov 2005
IPAM Bridging Time and Length Scales in Materials Science and Bio-Physics, Multiscale Analysis and Computation, Los Angeles, CA. <sup>†</sup>	Nov 2005
IMA New Directions Short Course: Quantum Computation, Minneapolis, MN. <sup>†</sup>	Aug 2005
International Forum on Multiscale Methods and Partial Differential Equations, Los Angeles, CA. <sup>†</sup>	Aug 2005
Quantum Control Summer School, Caltech, Pasadena, CA. <sup>†</sup>	Aug 2005
IPAM Grand Challenge Problems in Computational Astrophysics, Los Angeles, CA. Relativistic Astrophysics. <sup>†</sup>	May 2005
$N$ -Body Problems in Astrophysics. <sup>†</sup>	Apr 2005
Department of Mathematics, National University of Singapore, Singapore. <sup>‡,‡</sup>	Jul 2004
2004 CNA Summer School, Advances in Nonlinear Analysis, Center for Nonlinear Analysis, Carnegie Mellon University, Pittsburgh, PA. <sup>†</sup>	May–Jun 2004
DARPA Workshop on Design of Robust Dynamical Systems, UTRC, East Hartford, CT. <sup>†</sup>	Jan 2004
Advances and Mathematical Issues in Large Scale Simulation, Institute for Mathematical Sciences, National University of Singapore. <sup>‡</sup>	Feb 2003
Mathematical Challenges in Scientific and Engineering Computation, Newton Institute, University of Cambridge. <sup>‡</sup>	Jan 2003
Workshop on Geometry, Dynamics, and Mechanics, Fields Institute, Toronto, Canada. <sup>†</sup>	Aug 2002
Workshop on Astrodynamics, University of Surrey. <sup>†</sup>	Apr 2002
Workshop on Classical $N$ -Body Systems and Applications, University of Warwick. <sup>†</sup>	Apr 2002
LMS/EPSRC Short Course on Computational Differential Equations. <sup>†</sup>	Mar 2002
Groupoidfest, University of California, Berkeley, CA. <sup>‡</sup>	Nov 2001
Department of Informatics, University of Bergen, Bergen, Norway. Host: Prof. Hans Munthe-Kaas. <sup>#</sup>	Oct 2001
Department of Mathematical Sciences, Norwegian University of Science and Technology, Trondheim, Norway. Host: Prof. Brynjulf Owren. <sup>#</sup>	Oct 2001
Numerical Analysis Group, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, United Kingdom. Host: Prof. Arieh Iserles. <sup>‡</sup>	Aug–Sep 2001
Surface Water Waves, Newton Institute EuroConference, University of Cambridge. <sup>†</sup>	Aug 2001
5th PIMS Industrial Problem Solving Workshop, University of Washington, Seattle, WA. <sup>†</sup>	Jun 2001
4th PIMS Graduate Mathematics Modelling Camp, University of Victoria, BC, Canada. <sup>†</sup>	Jun 2001
2001 CNA Summer School, Multiscale Problems in Nonlinear Analysis, Center for Nonlinear Analysis, Carnegie Mellon University, Pittsburgh, PA. <sup>†</sup>	Jun 2001

<sup>†</sup>Funded by conference organizers. <sup>‡</sup>Funded by research grants. <sup>#</sup>Funded by host institution.

### Postdoctoral Scholars Advised

Joris Vankerschaver, Postdoctoral Scholar/Teaching Visitor, University of California, San Diego, 2010–2012.  
Tomoki Ohsawa, Postdoctoral Scholar/Teaching Visitor, University of California, San Diego, 2010–2012.  
Tatiana Shingel, Postdoctoral Scholar/Teaching Visitor, University of California, San Diego, 2009–2012.  
Diana Sosa Martín, Visiting Assistant Professor of Mathematics, Purdue University, 2008–2009.

## Melvin Leok: Curriculum Vitae

### Graduate Students Advised

- Jingjing Zhang (co-advised with Jialin Hong)  
Ph.D., Institute of Computational Mathematics, Chinese Academy of Sciences, Beijing, Spring 2010.
- Tomoki Ohsawa (dissertation committee member, advisors: Anthony M. Bloch and N. Harris McClamroch)  
Ph.D., Applied and Interdisciplinary Mathematics, University of Michigan, Spring 2010.
- Zubin Olikara (graduate advisory committee member, advisor: Kathleen C. Howell)  
M.S. Student, Aeronautics and Astronautics, Purdue University.
- Jia Li (dissertation committee member, advisor: Dongbin Xiu)  
Ph.D., Mathematics, Purdue University, Fall 2009.
- Taeyoung Lee (co-advised with N. Harris McClamroch)  
(Distinguished Achievement Award, Ivor K. McIvor Award, BGCE Student Paper Prize finalist,  
Rackham International Student Fellow, Rackham Predoctoral Fellow)  
Ph.D., Aerospace Engineering, University of Michigan, Ann Arbor, Spring 2008.
- Nalin A. Chaturvedi (dissertation committee member, advisors: N. Harris McClamroch and Dennis S. Bernstein)  
Ph.D., Aerospace Engineering, University of Michigan, Ann Arbor, Spring 2007.
- Masako Kishida (co-advised with Dennis S. Bernstein)  
M.S., Applied and Interdisciplinary Mathematics, University of Michigan, Ann Arbor, Spring 2006.

### Editorial and Refereeing Activities

- Editor, *Journal of Nonlinear Science* (Springer), 2008–present.
- Editor, *Journal of Geometric Mechanics* (American Institute of Mathematical Sciences), 2009–present.
- Editor, *Journal of Computational Dynamics* (American Institute of Mathematical Sciences), 2011–present.
- Editorial Advisor, *Journal of Computation and Mathematics* (London Mathematical Society), 2011–2016.
- Associate Editor, *Journal on Control and Optimization* (SIAM), 2012-2014.
- Referee, *Advances in Difference Equations, Aerospace Science and Technology, American Mathematical Monthly, Applied Numerical Mathematics, ASME Journal of Applied Mechanics, Automatica, BIT Numerical Mathematics, Celestial Mechanics and Dynamical Astronomy, Chinese Journal of Aeronautics, Communications in Computational Physics, Communications in Contemporary Mathematics, Communications in Numerical Methods in Engineering, Computational Science and Discovery, Computer Methods in Applied Mechanics and Engineering, Differential Equations and Dynamical Systems, Discrete & Continuous Dynamical Systems (Series B,S), ESAIM: Control, Optimisation and Calculus of Variations, Foundations of Computational Mathematics, IEEE Transactions on Automatic Control, IEEE Transactions on Control Systems Technology, IET Control Theory and Applications, IMA Journal of Numerical Analysis, International Journal of Non-Linear Mechanics, International Journal for Numerical Methods in Engineering, Journal of Computational Physics, Journal of Mathematical Physics, Journal of Nonlinear Science, Journal of Physics A, Journal of Symplectic Geometry, Mathematical and Computer Modelling, Nonlinearity, Numerical Algorithms, Numerische Mathematik, Physica D, Physics Letters A, Proceedings of the Royal Society A, Reliable Computing, SIAM Applied Dynamical Systems, SIAM Multiscale Modeling and Simulation, SIAM Journal on Control and Optimization, SIAM Journal on Mathematical Analysis, SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing, Symmetry, Integrability & Geometry: Methods & Applications, Soft Computing and Automation Journal, Transport in Porous Media.*
- Reviewer, *IEEE Conference on Decision and Control 2005–2009, 2011, IEEE Multi-conference on Systems and Control 2007, 2009, American Control Conference 2008–2011, IFAC 2011, ICNAAM 2009, 2010, Air Force Office of Scientific Research, Georgia National Science Foundation, International Centre for Mathematical Sciences in Edinburgh, NSERC Canada, Mathematical Reviews, Springer Books, Swiss National Science Foundation.*
- Panel member, Mathematical Sciences, National Science Foundation. Nov 2011
- Mail referee, International Science and Engineering, National Science Foundation. Mar 2011
- Mail referee, Applied Mathematics, National Science Foundation. Mar 2010
- Panel member, Computational Mathematics, National Science Foundation. Mar 2010
- Panel member, Mathematical Sciences Graduate Research Fellowship, National Science Foundation. Feb 2010
- Panel member, Applied Mathematics, National Science Foundation. Mar 2009
- Panel member, Computational Mathematics, National Science Foundation. Mar 2008

## Melvin Leok: Curriculum Vitae

### Conference, Workshop, and Minisymposium Organization

Co-organizer, computational methods for geometric PDEs minisymposium, ICIAM, Vancouver, Canada.	Jul 2011
Organizing committee member, geometric methods for optimal control semester, Madrid, Spain.	Jul–Dec 2010
Co-organizer, Sixth Annual Structured Integrators Workshop, UCSD, La Jolla, CA.	Apr 2010
Co-organizer, 26th Pacific Coast Gravity Meeting, UCSD, La Jolla, CA.	Mar 2010
Co-organizer, control of mechanical systems special session, IEEE CDC 2009, Shanghai, China.	Dec 2009
Organizer, computational mechanics minisymposium, SciCADE 2009, Beijing, China.	May 2009
Co-organizer, geometric mechanics and its applications minisymposium (MS 121), SIAM DS09.	May 2009
Co-organizer, Fifth Annual Structured Integrators Workshop, Caltech, Pasadena, CA.	May 2009
Co-organizer, nonlinear dynamics and control of mechanical systems invited session, IEEE CDC.	Dec 2006
Co-organizer, contemporary dynamical systems special session, AMS Annual Meeting.	Jan 2006
Co-organizer, geometric dynamics and its applications minisymposium (MS 59, 70), SIAM DS05.	May 2005
Co-organizer, CIMMS Workshop on Discrete Geometry for Mechanics, Pasadena, CA.	Oct 2003
Co-organizer, discrete geometry and geometric integration minisymposium (MS 38, 62), SIAM DS03.	May 2003
Co-organizer, CIMMS Workshop on Networks, Optimization and Duality, Pasadena, CA.	July 2002
Co-organizer, geometric integration minisymposium (MS 51, 69), SIAM DS01.	May 2001

### University Service

Member, Mathematics Undergraduate Honors and Awards Committee, UCSD.	2010–2012
Member, Mathematics Graduate Admissions Committee, UCSD.	2009–2012
Undergraduate Faculty Advisor, Applied Mathematics and Scientific Computation, UCSD.	2009–2012
Organizer, Computational and Applied Mathematics Seminar, Purdue University.	Fall 2008
Member, Engagement Pillar Group Committee, College of Science, Purdue University.	2008
Member, Computer Committee, Mathematics, Purdue University.	2007–2008
Judge, Undergraduate Research and Poster Symposium, Purdue University.	Apr 2007
Faculty advisor, Purdue Singaporean Students Association.	2006–2009
Panelist, Proposal Writing, Faculty Professional Development Program, University of Michigan.	Sep 2005
Panelist, Graduate School Discussion Panel, Undergraduate Math Club, University of Michigan.	Oct 2004
Officer, SIAM Student Chapter, Caltech.	2004
Member, Caltech Project for Effective Teaching, Caltech.	2002–2004
Judge, Semifinals, Doris S. Perpall Speaking Competition, Caltech.	Nov 2003
Judge, Mathematics/Applied Mathematics Session, Caltech SURF Seminar Day	Oct 2002, 2003
Member, Academics Committee, Graduate Student Council, Caltech.	2002
Coordinator, Geometric Mechanics Seminar, Control and Dynamical Systems, Caltech.	2002
Graduate Student Representative, Committee on Institute Programs, Caltech.	2001–2003
Director, CDS Option Representative, Graduate Student Council, Caltech.	2001–2002
Member, Committee on Teaching Assistant Training, Graduate Dean’s Office, Caltech.	2001–2002
Student Representative, Feynman Teaching Prize Selection Committee, Caltech.	2000
Director for Academic Affairs, Associated Students of Caltech (ASCIT).	1999–2000
Chairman, Academics and Research Committee, Caltech.	1999–2000
Student Representative, Core Curriculum Steering Committee, Caltech.	1999–2000
House Representative, Academics and Research Committee, Caltech.	1998–1999
Student Representative, Academic Policies and Curriculum Committee, Caltech.	1997–1999

## Melvin Leok: Curriculum Vitae

### Teaching Experience

#### UNIVERSITY OF CALIFORNIA, SAN DIEGO

<i>Instructor</i> , Geometric Mechanics (Math 277A)	Winter 2012
<i>Instructor</i> , Numerical Methods for Physical Modeling (Math 174)	Fall 2011
<i>Instructor</i> , Numerical Ordinary Differential Equations (Math 270C)	Spring 2011
<i>Instructor</i> , Introduction to Numerical Analysis (Math 170AB)	Winter/Fall 2010
<i>Instructor</i> , Introduction to Differential Equations (Math 20D)	Winter 2010
<i>Instructor</i> , Geometric Numerical Integration (Math 273A)	Fall 2009/10

#### CALIFORNIA INSTITUTE OF TECHNOLOGY

<i>Instructor</i> , Introductory Concepts for Dynamical Systems (CDS 104)	Spring 2009
---	-------------

#### PURDUE UNIVERSITY

<i>Instructor</i> , Numerical Analysis (Math/CS 514)	Fall 2008
<i>Instructor</i> , Geometric Numerical Integration (Math 692A)	Spring 2008
<i>Instructor</i> , Ordinary Differential Equations (Math 366)	Spring 2008
<i>Instructor</i> , Introduction to Differential Geometry and Topology (Math 562)	Fall 2007
<i>Instructor</i> , Ordinary Differential Equations (Math 266)	Spring 2007

#### UNIVERSITY OF MICHIGAN, ANN ARBOR

<i>Instructor</i> , Numerical Methods for Engineers and Scientists (Math 371/Engr 371)	Winter 2005/06, Fall 2005
<i>Instructor</i> , Applied Honors Calculus II (Math 156)	Fall 2004

### Professional Memberships

American Mathematical Society, Foundations of Computational Mathematics (Geometric Integration Interest Group), London Mathematical Society, Mathematical Association of America, Singapore Mathematical Society, Society for Industrial and Applied Mathematics (Dynamical Systems Activity Group).

### Miscellaneous

*Nationality*: Permanent resident of the United States of America (Green Card). Singapore citizen.

Publications

Available for download at <http://www.math.ucsd.edu/~mleok/>

Refereed Journal Papers

1. *Discrete Poincaré Lemma* (with M. Desbrun, J.E. Marsden), Appl. Numer. Math. **53** (2–4), 231–248, 2005.
2. *Discrete Routh Reduction* (with S.M. Jalnapurkar, J.E. Marsden, M. West), J. Phys. A: Math. Gen. **39**, 5521–5544 (Geometric Integration Special Issue, invited paper), 2006.
3. *Lie Group Variational Integrators for the Full Body Problem* (with T. Lee, N.H. McClamroch), Comput. Methods Appl. Mech. Engrg. **196** (29–30), 2907–2924, 2007.
4. *Lie Group Variational Integrators for the Full Body Problem in Orbital Mechanics* (with T. Lee, N.H. McClamroch), Celestial Mechanics and Dynamical Astronomy **98** (2), 121–144, 2007.
5. *Global Optimal Attitude Estimation using Uncertainty Ellipsoids* (with T. Lee, A.K. Sanyal, N.H. McClamroch), Systems and Control Letters, **57** (3), 236–245, 2008.
6. *Optimal Attitude Control of a Rigid Body using Geometrically Exact Computations on  $SO(3)$*  (with T. Lee, N.H. McClamroch), Journal of Dynamical and Control Systems **14** (4), 465–487, 2008.
7. *Discrete Control Systems* (with T. Lee, N. H. McClamroch), invited article for the Springer Encyclopedia of Complexity and Systems Science, 2002–2019, 2009.
8. *Geometric Structure-Preserving Optimal Control of the Rigid Body* (with A.M. Bloch, I.I. Hussein, A.K. Sanyal), Journal of Dynamical and Control Systems **15** (3), 307–330, 2009.
9. *Computational Geometric Optimal Control of Rigid Bodies* (with T. Lee, N.H. McClamroch), Brockett Legacy Special Issue, Communications in Information and Systems **8** (4), 445–472, 2008.
10. *Controlled Lagrangians and Stabilization of Discrete Mechanical Systems* (with A.M. Bloch, J.E. Marsden, D.V. Zenkov), Discrete and Continuous Dynamical Systems – Series S (Nonholonomic Constraints in Mechanics and Optimal Control Theory Special Issue), **3** (1), 19–36, 2010.
11. *Lagrangian Mechanics and Variational Integrators on Two-Spheres* (with T. Lee, N.H. McClamroch), International Journal for Numerical Methods in Engineering **79** (9), 1147–1174, 2009.
12. *Nonlinear Dynamics of the 3D Pendulum* (with N.A. Chaturvedi, T. Lee, N.H. McClamroch), Journal of Nonlinear Science, **21** (1), 3–32, 2011.
13. *Discrete Hamiltonian Variational Integrators* (with J. Zhang), IMA Journal of Numerical Analysis, **31** (4), 1497–1532, 2011.
14. *Computational Dynamics of a 3D Elastic String Pendulum Attached to a Rigid Body and an Inertially Fixed Reel Mechanism* (with T. Lee, N.H. McClamroch), Nonlinear Dynamics, **64** (1–2), 97–115, 2011.
15. *On the Geometry of Multi-Dirac Structures and Gerstenhaber Algebras* (with J. Vankerschaver, H. Yoshimura), Journal of Geometry and Physics, **61** (8), 1415–1425, 2011.
16. *Variational and Geometric Structures of Discrete Dirac Mechanics* (with T. Ohsawa), Foundations of Computational Mathematics, **11** (5), 529–562, 2011.
17. *Discrete Hamilton–Jacobi Theory* (with A.M. Bloch, T. Ohsawa), SIAM Journal on Control and Optimization, **49**(4), 1829–1856, 2011.
18. *Prolongation–Collocation Variational Integrators* (with T. Shingel), IMA Journal of Numerical Analysis, in press, 2011.
19. *General Techniques for Constructing Variational Integrators* (with T. Shingel), Frontiers of Mathematics in China (Special issue on computational mathematics, invited paper), accepted, 2011.
20. *Variational Integrators*, invited article for the Springer Encyclopedia of Applied and Computational Mathematics, accepted, 2012.
21. *Estimating the Attractor Dimension of the Equatorial Weather System*, Acta Phys. Pol. A **85**, S27–S35, 1994.

Refereed Conference Papers

22. *A Lie Group Variational Integrator for the Attitude Dynamics of a Rigid Body with Applications to the 3D Pendulum* (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Control Applications, 962–967, 2005.
23. *Controlled Lagrangians and Stabilization of the Discrete Cart–Pendulum System* (with A.M. Bloch, J.E. Marsden, D.V. Zenkov), Proc. IEEE Conf. on Decision and Control, 6579–6584, 2005.
24. *Attitude Maneuvers of a Rigid Spacecraft in a Circular Orbit* (with T. Lee, N.H. McClamroch), Proc. American Control Conf., 1742–1747, 2006.
25. *Polyhedral Potential and Variational Integrator Computation of the Full Two Body Problem* (with E. Fahnstock, T. Lee, N.H. McClamroch, D. Scheeres), Proc. AIAA/AAS Astrodynamics Conf., AIAA-2006-6289, 2006.
26. *Optimal Control of a Rigid Body using Geometrically Exact Computations on  $SE(3)$*  (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 2710–2715, 2006.
27. *Deterministic Global Attitude Estimation* (with T. Lee, A.K. Sanyal, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 3174–3179, 2006.

## Melvin Leok: Curriculum Vitae

### Publications (continued)

Available for download at <http://www.math.ucsd.edu/~mleok/>

#### Refereed Conference Papers (continued)

28. *Controlled Lagrangians and Potential Shaping for Stabilization of Discrete Mechanical Systems* (with A.M. Bloch, J.E. Marsden, D.V. Zenkov), Proc. IEEE Conf. on Decision and Control, 3333–3338, 2006.
29. *A Discrete Variational Integrator for Optimal Control Problems on  $SO(3)$*  (with A.M. Bloch, I.I. Hussein, A.K. Sanyal), Proc. IEEE Conf. on Decision and Control, 6636–6641, 2006.
30. *Global Attitude Estimation using Single Direction Measurements* (with T. Lee, N.H. McClamroch, A.K. Sanyal), Proc. American Control Conf., 3659–3664, 2007.
31. *Optimal Attitude Control for a Rigid Body with Symmetry* (with T. Lee, N.H. McClamroch), Proc. American Control Conf., 1073–1078, 2007.
32. *Propagation of Uncertainty in Rigid Body Attitude Flows* (with N.A. Chaturvedi, T. Lee, N.H. McClamroch, A.K. Sanyal), Proc. IEEE Conf. on Decision and Control, 2689–2694, 2007.
33. *A Combinatorial Optimization Problem for Spacecraft Formation Reconfiguration* (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 5370–5375, 2007.
34. *Matching and stabilization of discrete mechanical systems* (with A.M. Bloch, J.E. Marsden, D.V. Zenkov), Proc. Appl. Math. Mech. **7**, 1030603–1030604, 2007.
35. *Time Optimal Attitude Control for a Rigid Body* (with T. Lee, N.H. McClamroch), Proc. American Control Conf., 5210–5215, 2008.
36. *Global Symplectic Uncertainty Propagation on  $SO(3)$*  (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 61–66, 2008.
37. *Dynamics of Connected Rigid Bodies in a Perfect Fluid* (with T. Lee, N.H. McClamroch), Proc. American Control Conf., 408–413, 2009.
38. *Dynamics of a 3D Elastic String Pendulum* (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 3347–3352, 2009.
39. *Computational Geometric Optimal Control of Connected Rigid Bodies in a Perfect Fluid* (with T. Lee, N.H. McClamroch), Proc. American Control Conf., 5985–5990, 2010.
40. *Discrete Dirac Structures and Implicit Discrete Lagrangian and Hamiltonian Systems* (with T. Ohsawa), XVIII International Fall Workshop on Geometry and Physics, 91–102, AIP Conference Proceedings 1260, 2010.
41. *Geometric Tracking Control of a Quadrotor UAV on  $SE(3)$*  (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 5420–5425, 2010.
42. *Discrete Hamilton–Jacobi Theory and Discrete Optimal Control* (with T. Ohsawa, A.M. Bloch), Proc. IEEE Conf. on Decision and Control, 5438–5443, 2010.
43. *Stokes–Dirac Structures through Reduction of Infinite-Dimensional Dirac Structures* (with J. Vankerschaver, H. Yoshimura, J.E. Marsden), Proc. IEEE Conf. on Decision and Control, 6265–6270, 2010.
44. *Geometric Numerical Integration of Complex Dynamics of Tethered Spacecraft* (with T. Lee, N.H. McClamroch), Proc. American Control Conf., 1885–1891, 2011.
45. *Stable Manifolds of Saddle Points for Pendulum Dynamics on  $S^2$  and  $SO(3)$*  (with T. Lee, N.H. McClamroch), Proc. IEEE Conf. on Decision and Control, 3915–3921, 2011.
46. *Nonlinear Robust Tracking Control of a Quadrotor UAV on  $SE(3)$*  (with T. Lee, N.H. McClamroch), Proc. American Control Conf., accepted, 2012.

#### Papers under Review

47. *Control of Complex Maneuvers for a Quadrotor UAV using Geometric Methods on  $SE(3)$*  (with T. Lee, N.H. McClamroch), Asian Journal of Control, submitted, 2011.
48. *The Hamilton–Pontryagin Principle and Multi-Dirac Structures for Classical Field Theories* (with J. Vankerschaver, H. Yoshimura, J.E. Marsden), Journal of Mathematical Physics, submitted, 2011.
49. *Hamilton–Jacobi Theory for Degenerate Lagrangian Systems with Holonomic and Nonholonomic Constraints* (with T. Ohsawa, D. Sosa), Journal of Mathematical Physics, submitted, 2011.
50. *Generating Functionals and Lagrangian PDEs* (with C. Liao, J. Vankerschaver), Journal of Nonlinear Science (Marsden memorial issue, invited article), submitted, 2011.

#### Preprints

51. *Generalized Galerkin Variational Integrators*, 2004.
52. *A Discrete Theory of Connections on Principal Bundles* (with J.E. Marsden, A.D. Weinstein), 2004.
53. *Discrete Exterior Calculus* (with M. Desbrun, A.N. Hirani, J.E. Marsden), 2003.

## Melvin Leok: Curriculum Vitae

### References

**Anthony M. Bloch**

*Alexander Ziwet Collegiate Professor of Mathematics, University of Michigan, Ann Arbor.*  
Department of Mathematics, The University of Michigan, Ann Arbor, MI 48109, USA.  
(734)647-4980, [abloch@umich.edu](mailto:abloch@umich.edu)

**Darryl D. Holm**

*Professor of Applied Mathematics, Imperial College, London, UK.*  
Department of Mathematics, South Kensington Campus, Imperial College, London SW7 2AZ, UK.  
+44 20 7594 8531, [d.holm@imperial.ac.uk](mailto:d.holm@imperial.ac.uk)  
*Laboratory Fellow, Los Alamos National Laboratory.*  
T-7, MS B284, Los Alamos, NM 87545, USA.  
(505) 667-6398, [dholm@lanl.gov](mailto:dholm@lanl.gov)

**Michael J. Holst**

*Professor of Mathematics and Physics, University of California, San Diego.*  
9500 Gilman Drive #0112, Department of Mathematics, UCSD, La Jolla, CA 92093, USA.  
(858)534-4899, [mholst@math.ucsd.edu](mailto:mholst@math.ucsd.edu)

**Arieh Iserles**

*Professor in Numerical Analysis of Differential Equations, University of Cambridge, UK.*  
Centre for Mathematical Sciences, Wilberforce Road, Cambridge CB3 0WA, UK.  
+44 1223 337891, [A.Iserles@damtp.cam.ac.uk](mailto:A.Iserles@damtp.cam.ac.uk)

**Christian Lubich**

*Professor of Numerical Mathematics, University of Tübingen.*  
Mathematisches Institut, Universität Tübingen, Auf der Morgenstelle 10, D-72076, Tübingen, Germany.  
+49 7071 29 72935, [lubich@na.uni-tuebingen.de](mailto:lubich@na.uni-tuebingen.de)

**Richard M. Murray**

*Thomas E. and Doris Everhart Professor of Control & Dynamical Systems and Bioengineering, Caltech.*  
107-81, Caltech, Pasadena, CA 91125, USA.  
(626)395-6460, [murray@cds.caltech.edu](mailto:murray@cds.caltech.edu)

**N. Harris McClamroch**

*Professor of Aerospace Engineering, University of Michigan, Ann Arbor.*  
Department of Aerospace Engineering, The University of Michigan, Ann Arbor, MI 48109, USA.  
(734)763-2355, [nhm@engin.umich.edu](mailto:nhm@engin.umich.edu)

**Peter J. Olver**

*Professor of Mathematics, University of Minnesota.*  
*Head, School of Mathematics, University of Minnesota.*  
School of Mathematics, University of Minnesota, Minneapolis, MN 55455, USA.  
(612)625-5591, [olver@umn.edu](mailto:olver@umn.edu)

**Tudor S. Ratiu**

*Professor of Geometrical Analysis, École Polytechnique Fédérale de Lausanne, Switzerland.*  
*Director, Bernoulli Center, École Polytechnique Fédérale de Lausanne, Switzerland.*  
Department of Mathematics, Station 8, CH-1015 Lausanne, Switzerland.  
+41 21 6932777, [tudor.ratiu@epfl.ch](mailto:tudor.ratiu@epfl.ch)

**Alan D. Weinstein**

*Professor of the Graduate School, University of California, Berkeley.*  
Department of Mathematics, University of California, Berkeley, CA 94720, USA.  
(510)642-3518, [alanw@math.berkeley.edu](mailto:alanw@math.berkeley.edu)